



State of Utah

JON M. HUNTSMAN, JR.  
Governor

GARY R. HERBERT  
Lieutenant Governor

## Department of Administrative Services

KIMBERLY K. HOOD  
Executive Director

### Division of Facilities Construction and Management

F. KEITH STEPAN  
Director

# ADDENDUM #1

Date: January 16, 2007

To: Contractors

From: Rick James, Project Manager, DFCM

Reference: Mechanical System Remodel – Heber Wells Building  
Division of Facilities Construction and Management  
DFCM Project No. 06187310

Subject: **Addendum No. 1**

Pages	Addendum	1	page
	<u>Architectural Specifications/Drawings</u>	<u>21</u>	<u>pages</u>
	<b>Total</b>	<b>22</b>	<b>pages</b>

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***Note: This Addendum shall be included as part of the Contract Documents. Items in this Addendum apply to all drawings and specification sections whether referenced or not involving the portion of the work added, deleted, modified, or otherwise addressed in the Addendum. Acknowledge receipt of this Addendum in the space provided on the Bid Form. Failure to do so may subject the Bidder to disqualification.***

**1.1 SCHEDULE CHANGES – There are no schedule changes per this addendum.**

**1.2 GENERAL**

See attached VCBO Architecture addendum 001, Stage II – Mechanical System Remodel specifications and drawings.

**End of Addendum #1**

# addendum 002

project: DFCM Heber Wells Bldg Remodel  
 project no.: 05310  
 date: January 12, 2007  
 owner: DFCM  
 bid date: 01/17/2007  
 bid time: 01:30 PM  
 no. pages:

**PARTNERS**  
 Niels E. Valentiner, AIA  
 Steve H. Crane, FAIA  
 Peter R. Brunjes, AIA  
 Sean Onyon, AIA  
 Brent R. Tippets, AIA  
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 Vinson M. Johnson, AIA  
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 Sean Thompson, AIA  
 Jennifer L. Bennett  
 RoLynne W. Hendricks

## STAGE II - MECHANICAL SYSTEM REMODEL

Please note the bids will be turned at the Wasatch Building at the Utah State Fairpark

### Drawings

Item	Description
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2.1	Sheet MH-101 - Provide a continuous 4" x 4" x 1/8" angle at the wall separating the cooling coil area from the fan room (southeast corner of penthouse) Attach angle to existing ceiling framing and existing wall framing to secure existing wall.
2.2	See attached mechanical sheets for keynote revisions
2.3	Sheet EE-001 - Revise Equipment Schedule. See attached
2.4	Sheet EE-102 - Change conductor and conduit size designator on CT-1A and CT-1B from 2 to 8
2.5	Sheet EP-602 - Refer to attached revised partial one-line diagram. Bidders are cautioned that fan motors may be low RPM and full-load amperage of fan motors should be verified when sizing VFC's

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 David S. Cox  
 Karen M. Ferguson  
 Nathan H. Leavitt  
 Dan A. Nelson

### Specifications

Item	Description
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2.5	Replace Section 15269 Variable Frequency Controllers: See attached.

### Details

### Approvals

In addition to the manufacturers called out in the contract documents, the following manufacturers, trade names and products are acceptable with the provisions that they shall completely satisfy every requirement of the drawings, specifications, and all addenda, and shall

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conform to the design, quality and standards specified, established and required for the complete and satisfactory installation and performance of the building and all its respective parts. Any costs incurred due to the use of the following manufacturers shall be paid by the contractor.

<u>Section</u>	<u>Material</u>	<u>Manufacturer</u>	<u>Action</u>
15761	Air Coils	Temtrol	Approved

End of Addendum # 002

CC :



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## ADDENDUM

Heber Wells Cooling Replacement  
Addendum #1  
VCBO

January 12, 2007

### **MECHANICAL – DIV 15**

---

#### **SPECIFICATIONS**

##### **Section 15269 Variable Frequency Controllers:**

1. Section has been revised. Refer to attached re-issued specification section.

#### **DRAWINGS**

1. Keynotes have been revised. See attached sheets: MH-101-R1-1, MH-101-R1-2, and MH-101-R1-3.

#### **PRIOR APPROVALS**

Approval of equipment from catalog information indicated brand name and general characteristics are acceptable to the Engineer, but does not relieve the Contractor of the responsibility of providing equipment and accessories as specified unless specific mention of departments from specifications was made in the submittal and acknowledged in writing by the Engineer. Quantities and dimensions are not checked. We are retaining one set of submittal data for our files.

<u>SECTION</u>	<u>ITEM</u>	<u>MANUFACTURER</u>	<u>COMMENT</u>
15761	Air Coils	Tentrol	Approved

### **ELECTRICAL – DIV 16**

---

#### **GENERAL ITEMS**

##### **Division 16 Unit Price Bid Form**

1. The Division 16 Unit Price Bid Form is attached to this addendum and shall be completed by the apparent two low bidders within 24 hours after the bid opening. The unit prices given shall be guaranteed for the duration of the project, and is the same for adds or deducts.

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1. No changes.

#### **DRAWINGS**

##### **Sheet EE-001:**

## **ADDENDUM**

Heber Wells Cooling Replacement  
Addendum #1  
VCBO

January 12, 2007

1. Equipment Schedule: Refer to attached revised equipment schedule for CT-1A and CT-1B.

### **Sheet EP-102:**

1. Change conductor and conduit size designator on CT-1A and CT-1B from 2 to 8.

### **Sheet EP-602:**

1. Refer to attached revised partial one-line diagram.
2. Bidders are cautioned that fan motors may be low RPM and full-load amperage of fan motors should be verified when sizing VFC's.

**END OF ADDENDUM**

### **Attachments:**

Specifications Section 15269  
Division 16 Unit Price Bid Form  
MH-101-R1-1  
MH-101-R1-2  
MH-101-R1-3  
EE-001-R1-1  
EP-602-R1-1

Heber Wells Cooling Replacement  
DIVISION 16 UNIT PRICE BID FORM

DIVISION 16 - ELECTRICAL UNIT PRICE BID FORM

UNIT PRICES

1. **Devices:** Guarantee unit prices for each item listed. Change order (add or deduct) amounts for complete installation shall be the prices listed below multiplied by the quantities added or deducted. Unit price shall include material and labor for complete installation of wiring devices.

Include 50' of branch wiring or cabling (as applicable) with the following:

<u>Wiring Device</u>	<u>Unit Price</u>
Convenience Outlet	_____
GFCI outlet	_____
Weatherproof outlet	_____

2. Provide unit prices for the following:

3/4" CND, with 4 #12THWN	_____	Lf
3/4" CND, with 4 #10THWN	_____	Lf
1" CND, with 4 #8 THWN	_____	Lf
1.25" CND, with 4 #6 THWN	_____	Lf
3/4" CND	_____	Lf

3. Electrician billing rates per hour:

Superintendent	_____
Journeyman	_____
3rd year apprentice	_____
2nd year apprentice	_____
1st year apprentice	_____

## **SECTION 15269 - VARIABLE FREQUENCY CONTROLLERS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. This Section includes solid-state, PWM, VFCs for speed control of three-phase, squirrel-cage induction motors.

#### **1.3 DEFINITIONS**

- A. BMS: Building management system.
- B. IGBT: Insulated gate bipolar transistor.
- C. LAN: Local area network.
- D. PID: Control action, proportional plus integral plus derivative.
- E. PWM: Pulse-width modulated.
- F. THD: Total Harmonic Distortion.
- G. VFC: Variable frequency controller.

#### **1.4 SUBMITTALS**

- A. Product Data: For each type of VFC, provide dimensions; mounting arrangements; location for conduit entries; shipping and operating weights; and manufacturer's technical data on features, performance, electrical ratings, characteristics, and finishes.
  - 1. Include broadband filter performance data for each filter.
- B. Shop Drawings: For each VFC include printed copy and electronic copy in AutoCAD format.
  - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
    - a. Each installed unit's type and details.
    - b. Nameplate legends.
    - c. Short-circuit current ratings of integrated unit.
    - d. UL listing for series rating of overcurrent protective devices in combination controllers.
    - e. Features, characteristics, ratings, and factory settings of each motor-control center unit.
  - 2. Wiring Diagrams: Power, signal, and control wiring for VFC. Provide schematic wiring diagram for each type of VFC.

- C. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around VFCs where pipe and ducts are prohibited. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
- D. Manufacturer Seismic Qualification Certification: Submit certification that VFCs, accessories, and components will withstand seismic forces defined in Division 16 Section "Seismic Controls for Electrical Work." Include the following:
1. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
  2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Field Test Reports: Written reports specified in Part 3.
- F. Manufacturer's field service report.
- G. Operation and Maintenance Data: For VFCs, all installed devices, and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Closeout Procedures," include the following:
1. Routine maintenance requirements for VFCs and all installed components.
  2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
  3. Harmonic distortion reports.
  4. Bill of Materials with all spare parts ordering information.
- H. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.
- I. Customer Certifications:
1. Material Supply Bond: Submit material supply bond for VFCs covering equipment and services for the project. Include statement that completed installation complies with all requirements and provisions of the VFC specification.
  2. Compliance documentation for power quality requirements.
  3. Qualifications of technical engineering personnel responsible for support and warranty of equipment.
  4. Extended warranty/services contract proposal in compliance with specification requirements.
  5. Sample VFC approval form complying with DFCM requirements.
  6. Sample VFC system commissioning form complying with DFCM requirements.
  7. Sample VFC training approval form complying with DFCM requirements.
  8. Sample VFC quality assurance program and sample factory test and certification report forms complying with DFCM requirements.
  9. Include Certified As-built Drawings and AutoCAD files on floppy disks.



10. Submit warranty of manufacturers whose components comprise more than 25% of the cost of the system.
- J. Prototype Testing: For each type of VFC provide prototype testing of VFC with harmonic filtering. Perform each of the following tests under rated load at 0%, 50% and 100% of maximum rated frequency and submit results.
  1. Input voltage.
  2. Output voltage.
  3. Input current.
  4. Output current.
  5. Input voltage THD.
  6. Input current THD.
  7. DC bus voltage.

## **1.5 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Maintain, within 100 miles (160 km) of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.
- B. DFCM Approved Field Harmonic Testing and Documentation Consultants:
  1. Energy Management Corporation.
  2. Power Quality Consultants.
  3. Spectrum Engineers.
  4. Debenham Technical Services.
- C. Source Limitations: Obtain VFCs of a single type through one source from a single manufacturer.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, minimum clearances between VFCs, and adjacent surfaces and other items. Comply with indicated dimensions and clearances.
- F. Comply with NFPA 70.
- G. Assembly shall be UL Listed.

## **1.6 WARRANTY**

- A. Warranties, General: Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Special VFC Warranties: Written warranties, signed by manufacturer and Installer agreeing to replace components that fail in materials or workmanship within special warranty period.
  1. Special Warranty/Service Period: Two years from date of Substantial Completion.
    - a. Include pricing to renew service contract in two year increments thereafter.

- b. Include necessary repairs or loaner replacement assuring complete restoration of operation within 24 hours from the time a service call is requested. Pay a \$200 per day penalty for failure to comply with acknowledged service request.
- c. Include job site visits twice yearly by factory authorized service technician to inspect, clean, tune, and repair system.
- d. Include 200% performance bond on behalf of the Owner for the term of the service contract.

## **1.7 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver VFCs in shipping splits of lengths that can be moved past obstructions in delivery path as indicated.
- B. Store VFCs indoors in clean, dry space with uniform temperature to prevent condensation. Protect VFCs from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- C. If stored in areas subject to weather, cover VFCs to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

## **1.8 COORDINATION**

- A. Coordinate layout and installation of VFCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
- C. Coordinate features of VFCs, installed units, and accessory devices with pilot devices and control circuits to which they connect.
- D. Coordinate features, accessories, and functions of each VFC and each installed unit with ratings and characteristics of supply circuit, motor, motor speed, required control sequence, and duty cycle of motor and load.

## **1.9 EXTRA MATERIALS**

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Spare Fuses: Furnish one spare for every five installed, but not less than one set of three of each type and rating.
  - 2. Indicating Lights: Two of each type installed.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide VFC products by one of the following:
  - 1. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary.
  - 2. Motor Drives International.
  - 3. Yaskawa.

- B. Manufacturers: Subject to compliance with requirements, provide filtering products by one of the following:
1. MTE.
  2. General Electric Industrial Systems.
  3. Motor Drives International.

## 2.2 VARIABLE FREQUENCY CONTROLLERS

- A. Description: NEMA ICS 2, IGBT, PWM, VFC; listed and labeled as a complete unit and arranged to provide variable speed of a NEMA MG 1, Design B, 3-phase, standard or premium-efficiency induction motor, as specified in Division 15, by adjusting output voltage and frequency.
- B. Design and Rating: Match load type such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
- C. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.
- D. Unit Operating Requirements:
1. Input ac voltage with tolerance of plus or minus 10%; refer to drawings.
    - a. Voltage sag-ride-thru coordination: 0% voltage for one cycle, 60% voltage for 10 cycles, 90% voltage continuous.
  2. Input frequency tolerance of 50/60 Hz, plus or minus 6 percent.
  3. Capable of driving full load, under the following conditions, without derating:
    - a. Ambient Temperature
      - 1) Indoor: 0 to 40 deg C.
    - b. Humidity: Less than 90 percent (non-condensing).
    - c. Altitude: 4500 feet (1534 m).
  4. Minimum Efficiency: 98 percent at 60 Hz, full load.
  5. Minimum Displacement Primary-Side Power Factor: 96 percent.
  6. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
  7. Starting Torque: 100 percent of rated torque or as indicated.
  8. Speed Regulation: Plus or minus 1 percent.
  9. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.
  10. Radio Frequency Interference (RFI): Meet FCC part 15, subpart J, Class A device requirements for RFI above 7 MHz.
- E. Internal Adjustability Capabilities:
1. Minimum Speed: 5 to 25 percent of maximum rpm.
  2. Maximum Speed: 80 to 100 percent of maximum rpm.
  3. Acceleration: 2 to a minimum of 22 seconds.
  4. Deceleration: 2 to a minimum of 22 seconds.
  5. Current Limit: 50 to a minimum of 110 percent of maximum rating.
- F. Self-Protection and Reliability Features:
1. Input transient protection by means of surge suppressors.
  2. Snubber networks to protect against malfunction due to system voltage transients.
  3. Under- and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
  4. Motor Overload Relay: Adjustable electronic overload circuits with instantaneous trip, inverse time trip and current functions, and capable of NEMA 250, Class 20 performance.

5. Programmable skip frequencies to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
  6. Instantaneous line-to-line and line-to-ground overcurrent trips.
  7. Loss-of-phase protection.
  8. Reverse-phase protection.
  9. Short-circuit protection.
  10. Short circuit rating as indicated.
  11. Ground fault protection.
- G. Automatic Reset and Restart: To attempt three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bi-directional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.
- H. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.
- I. Torque Boost: Automatically vary starting and continuous torque to at least 1.5 times the minimum torque to insure high-starting torque and increased torque at slow speeds.
- J. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled fan-ventilated motors at slow speeds.
- K. Input Line Conditioning: Factory installed integral to the VFC enclosure as one UL listed assembly:
1. Motors 15HP and Smaller: AC line reactor and DC choke to limit current THD at the input terminals to 35% or less at rated load.
  2. Motors Greater than 15 HP: Any one of the following to limit the input current THD to 15% or less (where capacitive based filtering is used, provide contactor to disconnect capacitors when VFC has no load):
    - a. Hybrid filter.
    - b. 12 or 18-pulse rectifier.
    - c. Active front-end filter.
- L. VFC Output Filtering: Integral output filter where VFC is located greater than 50' (15 m) from the motor it's controlling.
- M. Status Lights: Door-mounted LED indicators shall indicate the following conditions:
1. Power on.
  2. Run.
  3. Overvoltage.
  4. Line fault.
  5. Overcurrent.
  6. External fault.
- N. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control potentiometer and elapsed time meter (nonkeypad controlled).
- O. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:
1. Output frequency (Hz).
  2. Motor speed (rpm).

# addendum 002

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### Drawings

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2.1	Sheet MH-101 - Provide a continuous 4" x 4" x 1/8" angle at the wall separating the cooling coil area from the fan room (southeast corner of penthouse) Attach angle to existing ceiling framing and existing wall framing to secure existing wall.
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Addendum #1  
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January 12, 2007

### **MECHANICAL – DIV 15**

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##### **Sheet EE-001:**

## **ADDENDUM**

Heber Wells Cooling Replacement  
Addendum #1  
VCBO

January 12, 2007

1. Equipment Schedule: Refer to attached revised equipment schedule for CT-1A and CT-1B.

### **Sheet EP-102:**

1. Change conductor and conduit size designator on CT-1A and CT-1B from 2 to 8.

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**END OF ADDENDUM**

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Heber Wells Cooling Replacement  
DIVISION 16 UNIT PRICE BID FORM

DIVISION 16 - ELECTRICAL UNIT PRICE BID FORM

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1.25" CND, with 4 #6 THWN	_____	Lf
3/4" CND	_____	Lf

3. Electrician billing rates per hour:

Superintendent	_____
Journeyman	_____
3rd year apprentice	_____
2nd year apprentice	_____
1st year apprentice	_____

## **SECTION 15269 - VARIABLE FREQUENCY CONTROLLERS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. This Section includes solid-state, PWM, VFCs for speed control of three-phase, squirrel-cage induction motors.

#### **1.3 DEFINITIONS**

- A. BMS: Building management system.
- B. IGBT: Insulated gate bipolar transistor.
- C. LAN: Local area network.
- D. PID: Control action, proportional plus integral plus derivative.
- E. PWM: Pulse-width modulated.
- F. THD: Total Harmonic Distortion.
- G. VFC: Variable frequency controller.

#### **1.4 SUBMITTALS**

- A. Product Data: For each type of VFC, provide dimensions; mounting arrangements; location for conduit entries; shipping and operating weights; and manufacturer's technical data on features, performance, electrical ratings, characteristics, and finishes.
  - 1. Include broadband filter performance data for each filter.
- B. Shop Drawings: For each VFC include printed copy and electronic copy in AutoCAD format.
  - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
    - a. Each installed unit's type and details.
    - b. Nameplate legends.
    - c. Short-circuit current ratings of integrated unit.
    - d. UL listing for series rating of overcurrent protective devices in combination controllers.
    - e. Features, characteristics, ratings, and factory settings of each motor-control center unit.
  - 2. Wiring Diagrams: Power, signal, and control wiring for VFC. Provide schematic wiring diagram for each type of VFC.

- C. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around VFCs where pipe and ducts are prohibited. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
- D. Manufacturer Seismic Qualification Certification: Submit certification that VFCs, accessories, and components will withstand seismic forces defined in Division 16 Section "Seismic Controls for Electrical Work." Include the following:
1. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
  2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Field Test Reports: Written reports specified in Part 3.
- F. Manufacturer's field service report.
- G. Operation and Maintenance Data: For VFCs, all installed devices, and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Closeout Procedures," include the following:
1. Routine maintenance requirements for VFCs and all installed components.
  2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
  3. Harmonic distortion reports.
  4. Bill of Materials with all spare parts ordering information.
- H. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.
- I. Customer Certifications:
1. Material Supply Bond: Submit material supply bond for VFCs covering equipment and services for the project. Include statement that completed installation complies with all requirements and provisions of the VFC specification.
  2. Compliance documentation for power quality requirements.
  3. Qualifications of technical engineering personnel responsible for support and warranty of equipment.
  4. Extended warranty/services contract proposal in compliance with specification requirements.
  5. Sample VFC approval form complying with DFCM requirements.
  6. Sample VFC system commissioning form complying with DFCM requirements.
  7. Sample VFC training approval form complying with DFCM requirements.
  8. Sample VFC quality assurance program and sample factory test and certification report forms complying with DFCM requirements.
  9. Include Certified As-built Drawings and AutoCAD files on floppy disks.

10. Submit warranty of manufacturers whose components comprise more than 25% of the cost of the system.
- J. Prototype Testing: For each type of VFC provide prototype testing of VFC with harmonic filtering. Perform each of the following tests under rated load at 0%, 50% and 100% of maximum rated frequency and submit results.
  1. Input voltage.
  2. Output voltage.
  3. Input current.
  4. Output current.
  5. Input voltage THD.
  6. Input current THD.
  7. DC bus voltage.

### **1.5 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Maintain, within 100 miles (160 km) of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.
- B. DFCM Approved Field Harmonic Testing and Documentation Consultants:
  1. Energy Management Corporation.
  2. Power Quality Consultants.
  3. Spectrum Engineers.
  4. Debenham Technical Services.
- C. Source Limitations: Obtain VFCs of a single type through one source from a single manufacturer.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, minimum clearances between VFCs, and adjacent surfaces and other items. Comply with indicated dimensions and clearances.
- F. Comply with NFPA 70.
- G. Assembly shall be UL Listed.

### **1.6 WARRANTY**

- A. Warranties, General: Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Special VFC Warranties: Written warranties, signed by manufacturer and Installer agreeing to replace components that fail in materials or workmanship within special warranty period.
  1. Special Warranty/Service Period: Two years from date of Substantial Completion.
    - a. Include pricing to renew service contract in two year increments thereafter.

- b. Include necessary repairs or loaner replacement assuring complete restoration of operation within 24 hours from the time a service call is requested. Pay a \$200 per day penalty for failure to comply with acknowledged service request.
- c. Include job site visits twice yearly by factory authorized service technician to inspect, clean, tune, and repair system.
- d. Include 200% performance bond on behalf of the Owner for the term of the service contract.

## **1.7 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver VFCs in shipping splits of lengths that can be moved past obstructions in delivery path as indicated.
- B. Store VFCs indoors in clean, dry space with uniform temperature to prevent condensation. Protect VFCs from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- C. If stored in areas subject to weather, cover VFCs to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

## **1.8 COORDINATION**

- A. Coordinate layout and installation of VFCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
- C. Coordinate features of VFCs, installed units, and accessory devices with pilot devices and control circuits to which they connect.
- D. Coordinate features, accessories, and functions of each VFC and each installed unit with ratings and characteristics of supply circuit, motor, motor speed, required control sequence, and duty cycle of motor and load.

## **1.9 EXTRA MATERIALS**

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Spare Fuses: Furnish one spare for every five installed, but not less than one set of three of each type and rating.
  - 2. Indicating Lights: Two of each type installed.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide VFC products by one of the following:
  - 1. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary.
  - 2. Motor Drives International.
  - 3. Yaskawa.

- B. Manufacturers: Subject to compliance with requirements, provide filtering products by one of the following:
1. MTE.
  2. General Electric Industrial Systems.
  3. Motor Drives International.

## **2.2 VARIABLE FREQUENCY CONTROLLERS**

- A. Description: NEMA ICS 2, IGBT, PWM, VFC; listed and labeled as a complete unit and arranged to provide variable speed of a NEMA MG 1, Design B, 3-phase, standard or premium-efficiency induction motor, as specified in Division 15, by adjusting output voltage and frequency.
- B. Design and Rating: Match load type such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
- C. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.
- D. Unit Operating Requirements:
1. Input ac voltage with tolerance of plus or minus 10%; refer to drawings.
    - a. Voltage sag-ride-thru coordination: 0% voltage for one cycle, 60% voltage for 10 cycles, 90% voltage continuous.
  2. Input frequency tolerance of 50/60 Hz, plus or minus 6 percent.
  3. Capable of driving full load, under the following conditions, without derating:
    - a. Ambient Temperature
      - 1) Indoor: 0 to 40 deg C.
    - b. Humidity: Less than 90 percent (non-condensing).
    - c. Altitude: 4500 feet (1534 m).
  4. Minimum Efficiency: 98 percent at 60 Hz, full load.
  5. Minimum Displacement Primary-Side Power Factor: 96 percent.
  6. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
  7. Starting Torque: 100 percent of rated torque or as indicated.
  8. Speed Regulation: Plus or minus 1 percent.
  9. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.
  10. Radio Frequency Interference (RFI): Meet FCC part 15, subpart J, Class A device requirements for RFI above 7 MHz.
- E. Internal Adjustability Capabilities:
1. Minimum Speed: 5 to 25 percent of maximum rpm.
  2. Maximum Speed: 80 to 100 percent of maximum rpm.
  3. Acceleration: 2 to a minimum of 22 seconds.
  4. Deceleration: 2 to a minimum of 22 seconds.
  5. Current Limit: 50 to a minimum of 110 percent of maximum rating.
- F. Self-Protection and Reliability Features:
1. Input transient protection by means of surge suppressors.
  2. Snubber networks to protect against malfunction due to system voltage transients.
  3. Under- and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
  4. Motor Overload Relay: Adjustable electronic overload circuits with instantaneous trip, inverse time trip and current functions, and capable of NEMA 250, Class 20 performance.

5. Programmable skip frequencies to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
  6. Instantaneous line-to-line and line-to-ground overcurrent trips.
  7. Loss-of-phase protection.
  8. Reverse-phase protection.
  9. Short-circuit protection.
  10. Short circuit rating as indicated.
  11. Ground fault protection.
- G. Automatic Reset and Restart: To attempt three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bi-directional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.
- H. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.
- I. Torque Boost: Automatically vary starting and continuous torque to at least 1.5 times the minimum torque to insure high-starting torque and increased torque at slow speeds.
- J. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled fan-ventilated motors at slow speeds.
- K. Input Line Conditioning: Factory installed integral to the VFC enclosure as one UL listed assembly:
1. Motors 15HP and Smaller: AC line reactor and DC choke to limit current THD at the input terminals to 35% or less at rated load.
  2. Motors Greater than 15 HP: Any one of the following to limit the input current THD to 15% or less (where capacitive based filtering is used, provide contactor to disconnect capacitors when VFC has no load):
    - a. Hybrid filter.
    - b. 12 or 18-pulse rectifier.
    - c. Active front-end filter.
- L. VFC Output Filtering: Integral output filter where VFC is located greater than 50' (15 m) from the motor it's controlling.
- M. Status Lights: Door-mounted LED indicators shall indicate the following conditions:
1. Power on.
  2. Run.
  3. Overvoltage.
  4. Line fault.
  5. Overcurrent.
  6. External fault.
- N. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control potentiometer and elapsed time meter (nonkeypad controlled).
- O. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:
1. Output frequency (Hz).
  2. Motor speed (rpm).

3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (VDC).
9. Set-point frequency (Hz).
10. Motor output voltage (V).

P. Control Signal Interface: Provide VFC with the following:

1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BMS or other control systems:
  - a. 0 to 10-V dc.
  - b. 0-20 or 4-20 mA.
  - c. Potentiometer using up/down digital inputs.
  - d. Fixed frequencies using digital inputs.
  - e. RS485.
  - f. Keypad display for local hand operation.
3. Output Signal Interface:
  - a. A minimum of 1 analog output signal (0-10v/4-20 mA), which can be programmed to any of the following:
    - 1) Output frequency (Hz).
    - 2) Output current (load).
    - 3) DC-link voltage (VDC).
    - 4) Motor torque (percent).
    - 5) Motor speed (rpm).
    - 6) Set-point frequency (Hz).
4. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
  - a. Motor running.
  - b. Set-point speed reached.
  - c. Fault and warning indication (overtemperature or overcurrent).
  - d. PID high or low speed limits reached.

Q. Communications: Provide an interface allowing VFC to be used with an external system within a multidrop LAN configuration. Interface shall allow all parameter settings of VFC to be programmed via BMS control. Provide capability for VFC to retain these settings within the nonvolatile memory.

1. Lonworks.
2. Coordinate with BMS installer.

R. Integral Disconnecting Means: NEMA AB 1, instantaneous-trip circuit breaker with lockable handle.

## 2.3 ENCLOSURES

- A. NEMA 250 with external operating handle and a safety interlock to prevent the door from opening when the unit is in operation. Mount all components in a single enclosure assembly. Include factory interconnecting wiring between all components. Do not exceed 90" high including concrete bases. Include removable panels to facilitate removal of components for maintenance. Include



minimum of two hinges with removable pins and stiffeners required for rigid door. Include minimum of oil-tight industrial operator devices in face of door.

1. Indoor Locations: Type 1.
2. Outdoor Locations: Type 3R
3. Other Wet or Damp Indoor Locations: Type 4.

B. Ventilation and Cooling: properly ventilate or cool VFCs for elevation and ambient environment.

## **2.4 ACCESSORIES**

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type oil tight.

C. Control Relays: Auxiliary and adjustable time-delay relays.

D. Standard Displays:

1. Output frequency (Hz).
2. Set-point frequency (Hz).
3. Motor current (amperes).
4. Motor voltage (volts).
5. DC-link voltage (VDC).
6. Motor torque (percent).
7. Motor speed (rpm).
8. Motor output voltage (V).

E. Historical Logging Information and Displays:

1. Running log of total power versus time.
2. Total run time.
3. Fault log, maintaining last four faults with time of operation stamp for each.

F. Control Circuit: Coordinate control voltage with control systems; control voltage obtained from integral control power transformer, unless otherwise indicated. Include a control power transformer with fuses and adequate capacity to operate connected pilot, indicating and control devices, plus 100 percent capacity.

## **2.5 FACTORY FINISHES**

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested VFCs before shipping.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

A. Examine areas, surfaces, and substrates to receive VFCs for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

- D. Install drive output dv/dt protective device for all motor circuits to ensure that the peak inverse voltage does not exceed 1000 V based upon manufacturer's published data.

### **3.2 APPLICATIONS**

- A. Select features of each VFC to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; and duty cycle of motor, drive, and load.
- B. Select rating of controllers to suit motor controlled.

### **3.3 INSTALLATION**

- A. Anchor each VFC assembly to steel-channel sills arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and grout sills flush with VFC mounting surface.
- B. Install VFCs on concrete bases complying with Division 3 Section "Cast-in-Place Concrete."
- C. Comply with mounting and anchoring requirements specified in Division 16 Section "Seismic Controls for Electrical Work."
- D. Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 16 Section "Fuses."

### **3.4 IDENTIFICATION**

- A. Identify VFCs, components, and control wiring according to Division 16 Section "Electrical Identification."
- B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

### **3.5 CONTROL WIRING INSTALLATION**

- A. Install wiring between VFCs and remote devices according to Division 16 Section "Conductors and Cables."
- B. Bundle, train, and support wiring in enclosures.
- C. Connect hand-off-automatic switch and other automatic-control devices where available.
  - 1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
  - 2. Connect selector switches with control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

### **3.6 CONNECTIONS**

- A. Conduit installation requirements are specified in other Division 16 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.
- B. Ground equipment.

- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

### **3.7 FIELD QUALITY CONTROL**

- A. Prepare for acceptance tests as follows:
  - 1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- B. Testing: Perform the following field quality-control testing:
  - 1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections 7.5, 7.6, and 7.16. Certify compliance with test parameters.
  - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  - 3. Document voltage and current waveforms for compliance with power quality standard. Include transformer derate analysis, telephone influence factor, true and displacement power factor, and voltage and current imbalance in the documentation.
  - 4. Run test conducted using actual motor accelerated and decelerated through the entire speed range.
  - 5. Control panel device tests: test switches, pilot lamps, keypad, special control devices.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including pretesting and adjusting VFCs.
- D. Test Reports: Prepare a written report to record the following:
  - 1. Test procedures used.
  - 2. Test results that comply with requirements.
  - 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

### **3.8 STARTUP SERVICE AND COMMISSIONING**

- A. Engage a factory-authorized service representative to perform startup service and commissioning:
  - 1. Verify input voltages comply with manufacturer's specified tolerances.
  - 2. Upon installation completion including water and air balancing, measure line voltage (L-L and L-N) and full load current of each phase of each VFC.
  - 3. Verify motor rotation in all modes of operation.
  - 4. Verify operator devices, programming and monitoring functions.
  - 5. Verify field signal control connections.
  - 6. Measure and report system output voltages and current at 50% and 100%. Tune output voltage to motor nameplate rating at full speed. Verify full load current against nameplate data.
  - 7. Tune and optimize VFC for application. Record configuration.
  - 8. Document that overload settings are set according to actual nameplate information.
- B. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 16 Sections.
- C. Complete installation and startup checks according to manufacturer's written instructions.

### **3.9 ADJUSTING**

- A. Set field-adjustable switches and circuit-breaker trip ranges.

### **3.10 CLEANING**

- A. Clean VFCs internally, on completion of installation, according to manufacturer's written instructions. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

### **3.11 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain VFCs. Refer to Division 1 Section "Closeout Procedures."
  - 1. Conduct a minimum of 4 hours of training (2 hours in the classroom and 2 hours in the field) in operation and maintenance.
  - 2. Schedule training with at least 7 day's advance notice.

**END OF SECTION 15269**

## SHEET KEYNOTES

1. REMOVE EXISTING 20HP RETURN FANS.
2. REMOVE EXISTING 100 HP SUPPLY FANS.
3. CUT HOLE IN WALL LARGE ENOUGH TO BRING IN NEW FAN EQUIPMENT. RELOCATE DOOR IF NECESSARY.
4. CONTRACTOR TO VERIFY SPACE AND MOUNTING REQUIREMENTS FOR NEW FANS. CONTRACTOR TO PROVIDE ANY NECESSARY MODIFICATIONS TO SUPPORT STRUCTURE FOR FAN INSTALLATION
5. COORDINATE CENTERLINE OF FANS AND SOUND TRAPS. MOUNT FANS ON SPRING ISOLATORS.
6. REMOVE EXISTING COOLING TOWER. CAP EXISTING CONNECTING PIPING FOR FUTURE CONNECTION WITH FUTURE COOLING TOWER.
7. REMOVE EXISTING COOLING COILS AND RELOCATE.
8. PATCH AND REPAIR HOLE TO MATCH EXISTING.
9. REMOVE EXISTING RELIEF AIR DAMPERS.
10. REMOVE EXISTING OUTSIDE AIR DAMPERS.
11. REMOVE EXISTING RETURN AIR DAMPERS.
12. PROVIDE 16' X 8' LOUVRE FOR DAMPER PRESSURE RELIEF. MOUNT TO FLOOR SUFFICIENT TO WITHSTAND MAXIMUM FAN PRESSURE. USE AIROLITE MODEL 609A OR EQUIVALENT.
13. RELOCATE WALL, DOOR, AND EXISTING FILTER BANK TO ALLOW 18" MINIMUM CLEARANCE BETWEEN FILTERS AND COILS.
14. CONNECT TO EXISTING CONDENSER WATER SUPPLY.
15. CONNECT TO EXISTING CONDENSER WATER RETURN.
16. EXISTING CHILLER PIPING.
17. NEW PIPE SHOWN IN BOLD TYP.
18. EXISTING COOLING COILS RELOCATED.



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DRAWN BY: ARA

CHECKED BY: JTJ

PROJECT

**HEBER M. WELLS BUILDING  
COOLING REPLACEMENT**

SHEET TITLE

**PENTHOUSE MECHANICAL  
AND DEMOLITION HVAC PLANS**

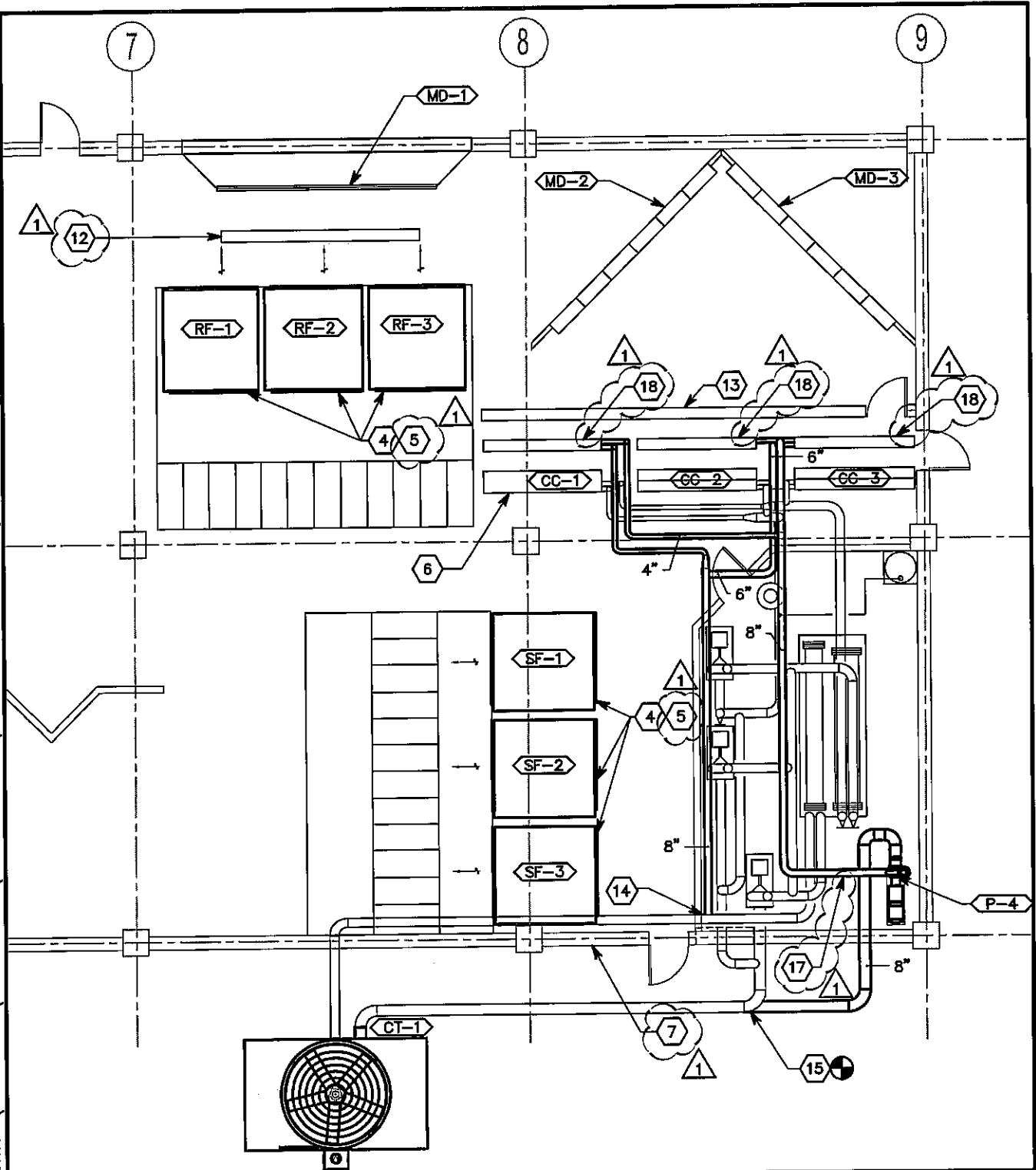
SCALE

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**MH-101-R1-1**

ITEM 2.2

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PROJECT  
**HEBER M. WELLS BUILDING  
COOLING REPLACEMENT**

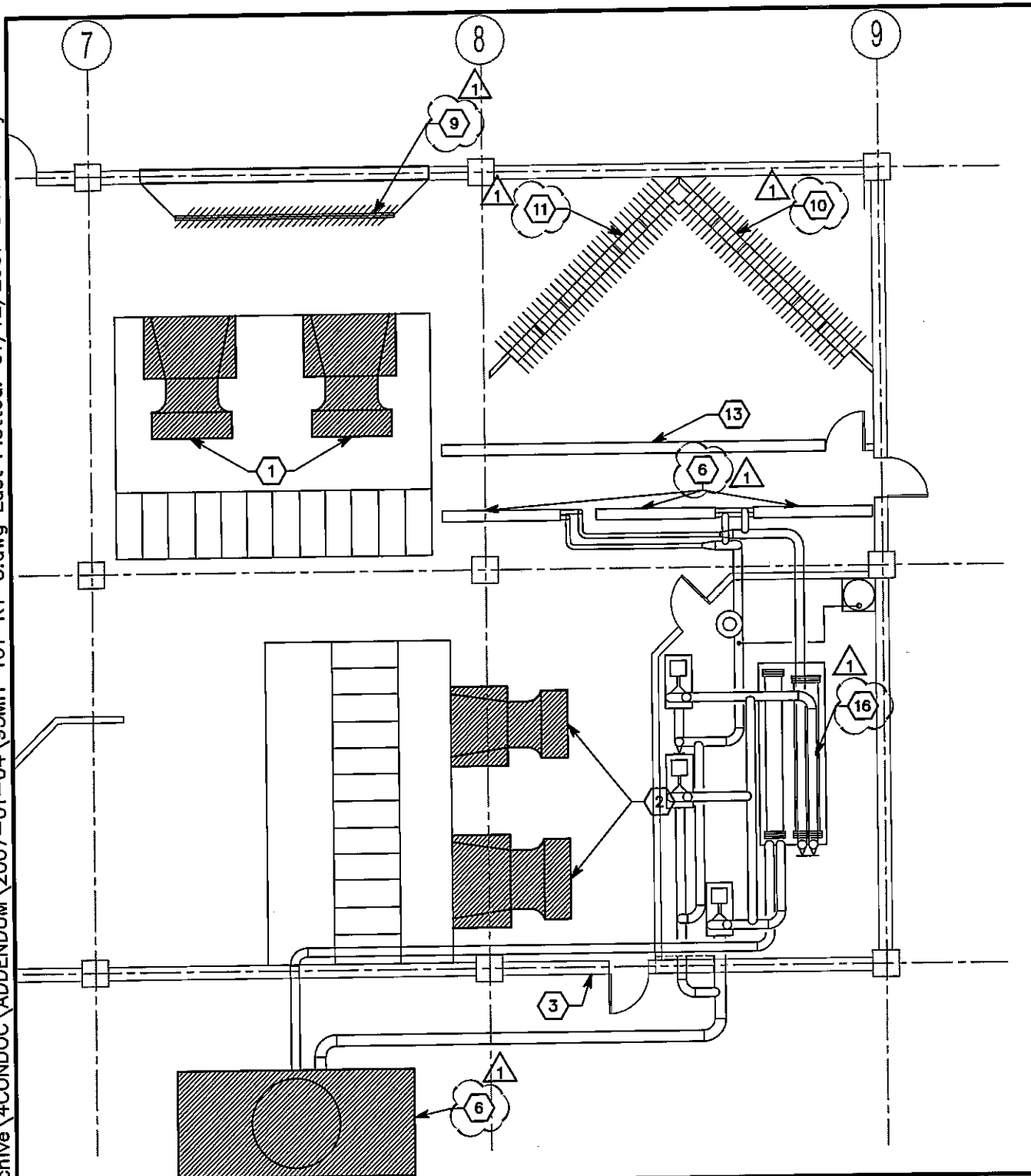
SHEET TITLE  
**PENTHOUSE  
MECHANICAL HVAC PLAN**

SCALE  
3/32"=1'-0"

**MH-101-R1-2**

ITEM 2.3

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PROJECT  
**HEBER M. WELLS BUILDING  
COOLING REPLACEMENT**

SHEET TITLE  
**PENTHOUSE MECHANICAL  
DEMOLITION HVAC PLAN**

SCALE  
3/32"=1'-0"

**MH-101-R1-3**

ITEM 2.3



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PROJECT  
**HEBER M. WELL COOLING REPLACEMENT**

SHEET TITLE  
**EQUIPMENT SCHEDULE**

SCALE  
 1/8"=1'-0"

**EE-001-R1-1**

## EQUIPMENT SCHEDULE

MARK	QTY	ITEM DESCRIPTION	LOAD DATA						WIRE AND CONDUIT SIZE		OVERCURRENT PROTECTION			DISCONNECT			
			HP	KW	MCA	FLA	VOLT	PH			Hz	FURN BY	DEVICE	LOCATION	FURN BY	DEVICE	LOCATION
		△ COOLING TOWER	15		21	480	3	60	3 #8, #10 GR 1" CND	E	MCP CB	MCC	E	30A/3P NO FUSE	ADJ. TO EQUIP.	E	S
CT-1A		COOLING TOWER	15		21	480	3	60	3 #8, #10 GR 1" CND	E	MCP CB	MCC	E	30A/3P NO FUSE	ADJ. TO EQUIP.	E	S
CT-1B		COOLING TOWER	15		21	480	3	60	3 #8, #10 GR 1" CND	E	MCP CB	MCC	E	30A/3P NO FUSE	ADJ. TO EQUIP.	E	S
CT-1H		COOLING TOWER SUMP HEATER	6		7.2	480	3	60	3 #12, #12 GR 0.75" CND	E	30A/3P CB	MCC	E	30A/3P NO FUSE	ADJ. TO EQUIP.	E	E
P-4		ECONOMIZER PUMP	25		34	480	3	60	3 #6, #10 GR 1" CND	E	60A/3P CB	MCC	Q	VFC NO FUSE	ADJ. TO EQUIP.	Q	V
RF-1		RETURN FAN	30		40	480	3	60	3 #4, #8 GR 1.25" CND	E	70A/3P CB	MCC	Q	VFC	ADJ. TO EQUIP.	Q	V
RF-2		RETURN FAN	30		40	480	3	60	3 #4, #8 GR 1.25" CND	E	70A/3P CB	MCC	Q	VFC	ADJ. TO EQUIP.	Q	V
RF-3		RETURN FAN	30		40	480	3	60	3 #4, #8 GR 1.25" CND	E	70A/3P CB	MCC	Q	VFC	ADJ. TO EQUIP.	Q	V
SF-1		SUPPLY FAN	100		124	480	3	60	3 #4/0, #4 GR 2.5" CND	E	225A/3P CB	MCC	Q	VFC	ADJ. TO EQUIP.	Q	V
SF-2		SUPPLY FAN	100		124	480	3	60	3 #4/0, #4 GR 2.5" CND	E	225A/3P CB	MCC	Q	VFC	ADJ. TO EQUIP.	Q	V

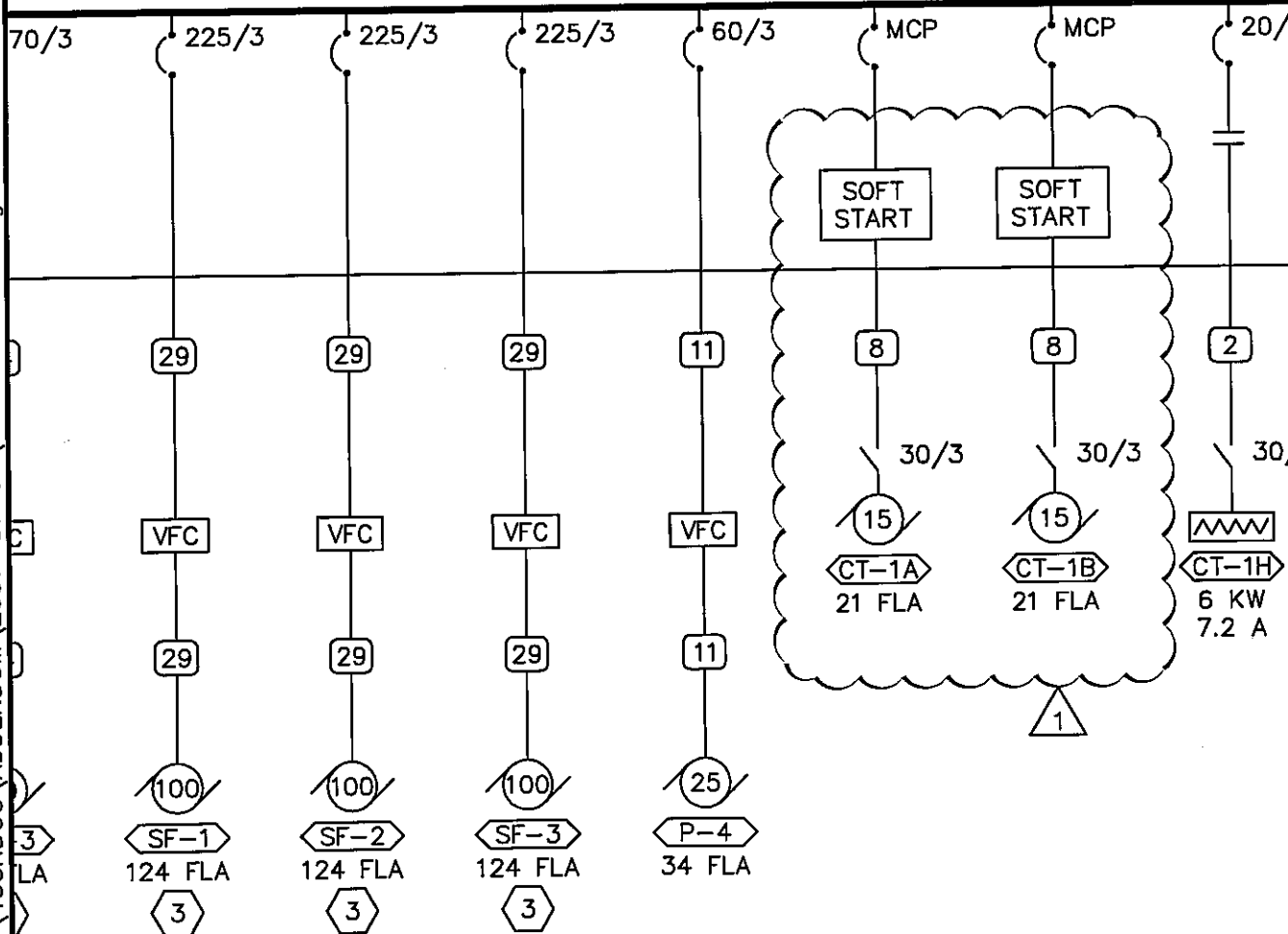
## EQUIPMENT SCHEDULE

STARTER DATA																	NOTES	MARK	
DISCONNECT		LOCATION	FURN BY	DEVICE	LOCATION	SIZE	SPEED	CTRL VOLT	SELECTOR SWITCH	PUSH BUTTON	PILOT LAMP	NORMALLY OPEN CONTACTS	NORMALLY CLOSED CONTACTS	PHASE FAILURE RELAY	SCHEMATIC REFERENCE	REMOTE CTRL			
30A/3P NO FUSE	ADJ. TO EQUIP.	E	SOFT START	MCC	2				HOA		R,G	2	2	YES				CT-1A	
30A/3P NO FUSE	ADJ. TO EQUIP.	E	SOFT START	MCC	2				HOA		R,G	2	2	YES				CT-1B	
30A/3P NO FUSE	ADJ. TO EQUIP.	E	SOFT START	MCC					HOA		R,G	2	2	NO				CT-1H	
VFC	ADJ. TO EQUIP.	Q	VFC	ADJ. TO EQUIP.														P-4	
VFC	ADJ. TO EQUIP.	Q	VFC	ADJ. TO EQUIP.														RF-1	
VFC	ADJ. TO EQUIP.	Q	VFC	ADJ. TO EQUIP.														RF-2	
VFC	ADJ. TO EQUIP.	Q	VFC	ADJ. TO EQUIP.														RF-3	
VFC	ADJ. TO EQUIP.	Q	VFC	ADJ. TO EQUIP.														SF-1	
VFC	ADJ. TO EQUIP.	Q	VFC	ADJ. TO EQUIP.														SF-2	
VFC	ADJ. TO EQUIP.	Q	VFC	ADJ. TO EQUIP.														SF-3	

ITEM 2.3



**NEW  
MCC2  
277/480V 3 $\phi$ , 4W, 800A**



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ITEM 2.5